"WITH INNOVATION COMES RESPONSIBILITY"

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INTRODUCTION

The word "sustainability" has taken on renewed focus for society as a whole and businesses and other entities in general. The past few years have demonstrated that an unanticipated event can disrupt economies, cause widespread loss of life, and bring the global society to a standstill.

One recognizes that throughout history, businesses in the guise of economic growth and employment, have managed to damage the environment and place the health and safety of humans and animals/wildlife at risk. In his book "Collapse: How Complex Societies Choose to Fail or Survive "(1), Jared Diamond recounts several examples of how well-intentioned firms have damaged the environment as well as placed its entire business at risk. One definition of "sustainability" considers how natural systems function and remain diverse enough to produce everything needed for systems to remain in balance.

This also acknowledges that human civilization consumes resources to sustain our modern way of life (1). There are countless examples throughout human history where a civilization has damaged its own environment and seriously affected its own survival chances (some of which Jared Diamond explores in his book Collapse: How Complex Societies Choose to Fail or Survive (1). Sustainability considers how we might live in harmony with the natural world around us, protecting it from damage and destruction.

And this goes much deeper than simply balancing the needs of society and the requirements on a business that provides employment. We consume more resources every year than we can put back and that needs to change. In terms of sustainability, it is all about balancing that fine line between competing needs – The need to expand our technological capabilities and innovations and the needs of the health and safety of our citizens and the environments where we all live.

Sustainability is not just about the environment (2) it's also about our health as a society in ensuring that no people or areas of life suffer as a result of environmental legislation. It's also about examining the longer-term effects of the actions humanity takes and asking questions about how it may be improved (2).

And that brings us to this conundrum.

THE CONUNDRUM

Yes, it is a fact this author works in an industry that consumes resources, water, energy, chemicals. And yes, regardless the author recognizes that we must all do our part to sustain the business as well as our environment.

The U.S. Environmental Protection Agency (EPA) has publicly stated that the regulatory body will revisit the risk evaluations completed to date under the Toxic Substances Control Act (TSCA) and that they are re-evaluating how they will complete future risk evaluations. There are several specific chemicals that are under increased scrutiny. These include chlorinated solvents, phthalates, TBBPA, and NMP. In addition, formaldehyde, a common chemical used in the formulation for copper plating, is undergoing increased scrutiny. It would be helpful to all concerned parties that as an industry, rather than fight the EPA, time could be better spent in two ways:

(1) Industry could be using this "found time" to do more to prepare their data/info on their uses/risks/etc. on chemicals that are on the "list"

(2) Industry can work with its suppliers to find alternatives that are environmentally friendly and will not incur the scrutiny that other substances are or will be under increased scrutiny or implementing alternative processes.

These concerns aside, what do we need to know about the hazardous use of chemicals in any industry?

> How can we encourage/require/scare the electronics industry into knowing what chemicals/materials they use, why they use it, and how they use it?

> Why wait for a regulation that tells you that you can’t use a chemical/material when you can instead be:

- working on supply chain transparency/traceability of chemical and material content now
- using this data/info on supply chain transparency to make better decisions about suppliers, designers, and design in general.
- using these data to ensure continued (safe) use of chem/mats that are essential to the product’s life cycle.
- using these data to justify finding safer chemistries and processes (and doing tradeoff analyses, LCAs, etc. to ensure they are “better” across life cycle)

We are in a society that is seeing unparalleled technological innovation across most industries. These innovations provide lifesaving and safety enhancing opportunities. So, why not put these innovations to work to reduce waste and greenhouse emissions, as well as provide materials and chemicals that are safer to the health of humans and to the environment. Consider the program that was undertaken several years ago under the direction of the U.S. Environmental Protection Agency’s team working on relevant design-for-the-environment issues.

DESIGN FOR THE ENVIRONMENT-PROJECT BACKGROUND (3)

In partnership with EPA and members of the electronics industry, the University of Tennessee Center for Clean Products and Clean Technologies conducted a life-cycle assessment (LCA) of tin-lead and lead-free solders used in the electronics industry. The project focused on tin-lead and the following three promising lead-free solders:

- 99.3% tin and 0.7% copper.
- 95.5% tin, 4.0% silver, and 0.5% copper.
- 92.3% tin, 3.4% silver, 1.0% copper, and 3.3% bismuth.

The study generated data to help manufacturers, users, and suppliers of solder to incorporate environmental considerations into their decision-making processes. The LCA examined the full life cycle and estimates were made for environmental impacts from each of the following life cycle stages:

- Raw materials extraction or acquisition and materials processing
- Solder manufacturing
- Solder Application
- End-of-life disposition

The project generated information that can be used by the electronics industry to select lead-free solders that work well for a given application, and that may have fewer impacts on public health and the environment. The LCA also identified areas that need further investigation and may help organizations to better manage their electronics purchasing and end-of-life disposition.

GREEN CIRCUITRY AND THE PROCESSES USED TO MANUFACTURE

We all live on this planet. And as consumers we need to do everything we can to protect our Earth for generations to come. As well-published elsewhere, there are concerns with water usage and cleanliness, dangerous chemicals that not only harm the environment but also are harmful to humans, as well as the potential for toxic emissions. Regardless of what industry we are talking about, there will always be consumption of chemicals and materials in the manufacturing of these end products. Some are more at risk than others.

A LEAD-FREE WORLD

The electronics industry complies with EU REACH Regulation and EU RoHS Directive requirements and the overarching push towards eliminating known hazardous materials – like lead -- and managing all materials throughout their life cycles to lessen impacts at end of life. . However, not all of the electronics OEMs and manufacturers have embraced lead-free soldering and lead-free assembly. For many years, the electronics industry embraced lead-based solders because the prevailing wisdom was that lead-based solders were more reliable and cost effective. For many firms, there was no economic or technical rationale to convert to lead-free assembly. About two decades ago, the EU called attention to the long-term health and environmental risks of lead-based materials. The EU and many other countries have limited the use of lead-based materials with few exemptions. And yet, private companies continue to raise concerns that lead-free materials are less reliable than lead-based counterparts. However, thanks to the Industry Consortium entity High Density Packaging User Group (HDPUG), the organization has performed extensive studies on the performance and reliability of lead-free solders. HDPUG carried out several projects measuring the long-term reliability of lead-free solders: particularly low silver alloy solder pastes. This significant work of the consortium provided sufficient evidence that many lead-free solder alloys used for PWB assembly are indeed reliable with respect to thermal fatigue and long-term reliability. Risk mitigation strategies are in place where lead-free alloys are concerned (4). Aerospace and Defense sector has reservations that lead-free alloys for assembly may not be reliable for some high temperature-high reliability applications. The concern here is that for these select applications, there is no suitable lead-free replacement.

PFAS

Recently, the European Chemicals Agency (ECHA) proposed a restriction – with the effect being a ban -- on the use of PFAS (per-and polyfluoroalkyl substances). PFAS are used throughout the electronics supply chain including printed circuit boards, cable and wire harnesses, conformal coatings, low-loss materials and battery materials. And these are just a few of the many uses and applications for PFAS materials. The unique properties of PFAS offer benefits of thermal stability, chemical inertness, dielectric strength among other properties. If these materials are universally restricted or subject to a ban, the entire electronics industry (medical, aerospace, telecommunication, cyber security, defense, and even day-to-day operations such as information technology and mobile phones) would be negatively impacted.

Electronic systems are highly complex units, with most of these must operate continuously in harsh use environments, including outer space and lifesaving and support medical devices. The mission-critical nature of these products necessitate use of PFAS materials due to the unique properties including high dielectric strength, ability to withstand harsh and corrosive environments, and ability to withstand high operating temperatures without breaking down. A sudden whole-sale ban or wide restriction would severely curtail the production of critical electronic equipment.

Certainly, the electronics industry has already made significant investments and innovations designed to reduce hazardous materials, minimize greenhouse gas emissions, and be stewards of the environment. And innovation will continue. However, the PFAS restrictions that are under consideration must allow time for alternatives to be developed and evaluated. This does not happen overnight. The electronics industry is taking steps to develop and consider alternatives. However, the extreme complexity of electronics necessitates a thorough approach to evaluating non-PFAS options. This is not a trivial task. It will take time and resources (financial and human) to find safer and proper functioning alternatives (5).

In Table 1, there is a listing of just a few key applications and uses for PFAS containing materials in electrical and electronic equipment (EEE). (6) The table provides examples f PFAS-containing and potential PFAS-containing articles and complex objects where substitution can be complex or there are no known alternatives.

Table 1. Examples of PFAS-containing and potential PFAS-containing EEE

Major applications of PFAS in EEE	Properties where PFAS are required *Note: not all requirements apply to all applications)*	Typical articles in EEE with this type of application of PFAS	Typical EEE containing articles with this type of application of PFAS
Additives in adhesives	Chemical properties	Structural adhesives	Various EEE, HDDs, etc.
Battery materials	Chemical, electrochemical, and thermal stability, mechanical flexibility, adhesion properties, permeation resistance, low surface tension	Batteries (binder material for electrodes, Lithium salt anions and additives for electrolyte, Separator material, Sealing and insulation materials)	Various EEE, batteries, ICT equipment, etc.
Coatings and thin film materials	Water and oil repellency, chemical resistance, electrical characteristics, dielectric properties resistant to UV radiation, thermal stability, cleanliness, low surface tension, mechanical stability, manufacturability, low transmission loss at high frequencies, wide frequency range, flame retardancy	Printed circuit boards, flexible circuit coatings, semiconductors, small electronic components (e.g., capacitors, resistors, coils, diodes, transistors, switches, connectors, and electrical junction points), motors, voice coils, liquid crystal panels, touch panels, optical sensors, LED, Toslink, optical fibers, lenses for electronic cameras, projection lenses, polarizers, anti-solder coating, printing applications, epilame in motors	Various EEE, mobile phones, tablets, printers, cameras, HDDs, medical devices, ICT equipment, etc.
Display materials	Low anisotropic refractive index, low viscosity, low voltage drive, heat resistance, durability, dipole moment, chemical and moisture permeation resistance, low surface tension	Liquid crystal and flat panel display materials and coatings	Various EEE, TVs, monitors, displays, etc.
Membrane materials (vents)	Cleanliness, formability, manufacturability, particle filtration efficiency, permeability to water and organic vapors, thermal stability, chemical stability	Filter membranes, filter assemblies	Various EEE, printers, computers, HDDs, mobile phones, smart watches, ICT equipment,
Fire prevention, insulation material (safety)	Low dieletric constant, electrical insulation, flame retardancy, chemical resistance, heat resistance, corrosion resistance, crack resistance, durability, dripping prevention, machineability	Insulation on cables, wires, and tubing, seals, enclosures, connectors, immersion cooling fluid for data centers, etc.	Various EEE, cables, monitors, medical equipment, electric appliances, industrial control equipment, printers, ICT equipment, etc.

Table 1. Examples of PFAS-containing and potential PFAS-containing EEE (continued)

Major applications of PFAS in EEE	Properties where PFAS are required *Note: not all requirements apply to all applications)*	Typical articles in EEE with this type of application of PFAS	Typical EEE containing articles with this type of application of PFAS
Lubricants and additives in lubricants	Lubrication properties, chemical stability, insulation properties, non-stick properties, thermal stability, electrochemical stability, mechanical reliability, uniformity, cleanliness, manufacturability, and hydrophobicity	Motors, tape cartridges, tape drives, tape cells, robotics, disks in HDDs, wire coatings, etc.	Various EEE, cameras, motors, fans, HDDs, electric appliances, medical equipment, industrial control equipment, tape libraries, etc.
Mechanical materials	Lubricity and abrasion resistance, low coefficient of friction, flame retardancy, durability, physical properties, low water absorption, low moisture permeability, cleanliness, low stickiness, and manufacturability.	Sliding parts, guides, pistons, seals, bumpers, motors, tubing, protective coatings, image forming parts of printers, industrial brakes, brakes, etc.	Various EEE, motors, fans, printers, HDDs, industrial equipment, cameras, displays, etc.
Optical materials	Water and oil repellency, flame retardancy, high transmissivity of light, low refractive index	Optical fiber, plastic optical fiber, optical lens, LED, monitors, panels, fiberglass, optical adhesive, protective coating material, anti-reflective material, etc.	Various EEE, mobile phones, cameras, lighting, monitors, panels, optical cable, ICT equipment, etc.
Piezoelectric materials	Piezoelectricity, durability, heat resistance, flexibility, manufacturability	Films in speakers, microphones, touch panel, sensors, actuators, etc.	Various EEE, touch panels, speakers, sensors, microphones, etc.
Printed circuit board materials	Flame retardancy, dielectric properties, electrical performance characteristics, temperature stability (high and low), low water absorption, mechanical characteristics, repellency, surface tension	Printed circuit boards (rigid, flexed, hybrid) - various uses	Various EEE, transportation/mobility, ICT equipment, base stations, aerospace, etc
Printing materials	Low surface tension, electrical insulation, water repellency, oil repellency, chemical resistance, surface activity, high negative charge	Toner additives, Ink additives, Developer additives	Printers

Source: IPC Response to the Proposed Restriction of PFAS

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